What is Theoretical Computer Science?

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What the guide book says. . .

“Tietojenkäsittelyteoria kehittää ja soveltaa matemaattisia menetelmiä tietojenkäsittelytehtävien systemaattiseen mallintamiseen, analysointiin ja ratkaisuun.” (TKK Tietotekniikan opinto-opas 2002–03)

“Theoretical computer science develops and applies mathematical methods for the systematic modelling, analysis, and solution of computational tasks.” (HUT Study Guide T 2002–03)

Research groups at the HUT TCS Lab

1. Computational Logic (Ilkka Niemelä)
2. Comput. Complexity and Combinatorics (P.O.)
3. Cryptography (Helger Lipmaa)
4. Mobility Management (Hannu Kari)
5. Verification (Nisse Husberg)

A taxonomy of TCS from 1990 (outdated)

Handbook of Theoretical Computer Science
Vol. A: Algorithms and Complexity

1. Machine Models and Simulation
2. A Catalog of Complexity Classes
3. Machine-Independent Complexity Theory
4. Kolmogorov Complexity and its Applications
5. Algorithms for Finding Patterns in Strings
6. Data Structures
7. Computational Geometry
8. Algorithmic Motion Planning in Robotics
9. Average-Case Analysis of Algorithms and Data Structures
10. Graph Algorithms
11. Algebraic Complexity Theory
12. Algorithms in Number Theory
13. Cryptography
14. The Complexity of Finite Functions
15. Communication Networks

16. VLSI Theory
17. Parallel Algorithms for Shared-Memory Machines
18. General Purpose Parallel Architectures

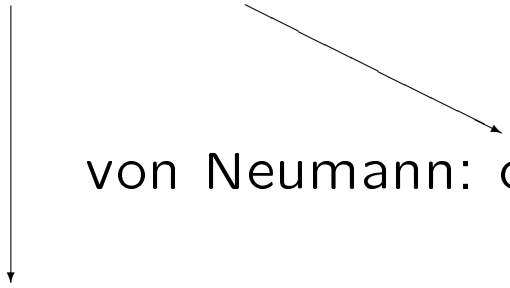
Handbook of Theoretical Computer Science
Vol. B: Formal Models and Semantics

1. Finite Automata
2. Context-Free Languages
3. Formal Languages and Power Series
4. Automata on Infinite Objects
5. Graph Rewriting: An Algebraic and Logic Approach
6. Rewrite Systems
7. Functional Programming and Lambda Calculus
8. Type Systems for Programming Languages
9. Recursive Applicative Program Schemes
10. Logic Programming
11. Denotational Semantics

12. Semantic Domains
13. Algebraic Specification
14. Logics of Programs
15. Methods and Logics for Proving Programs
16. Temporal and Modal Logic
17. Elements of Relational Database Theory
18. Distributed Computing: Models and Methods
19. Operational and Algebraic Semantics of Concurrent Processes

Research directions in TCS: A longitudinal example

Turing: computability 1936



von Neumann: computers 1946-47

Hartmanis et al.: comput. complexity 1964-65

Cook et al.: NP completeness 1971

Diffie & Hellman: cryptography 1976

RSA 1978

Three trends in TCS

1. Increased importance of stochastic and statistical methods
   - stochastic algorithms
   - dealing with "natural" data

2. Broadening of mathematical basis

3. Increasing interdisciplinary collaboration:
   - physics: stochastic optimisation, complex systems, quantum computation
   - biology: DNA computing, genetic and evolutionary models, bioinformatics

Some WWW resources

HUT TCS lab link collection:

`http://www.tcs.hut.fi/Links`

Discussion on the goals and results of TCS:

Challenges for TCS (NSF 2000)

`http://www.research.att.com/~dsj/nsflist.html`

Challenges for Theory of Computing (NSF 1999)

`http://www.cse.buffalo.edu/~selman/report/`

Contributions of TCS (ACM SIGACT 1996)

`http://sigact.acm.org/sigact/longrange/contributions.html`